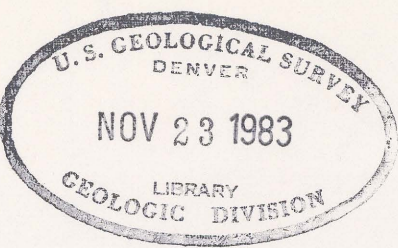


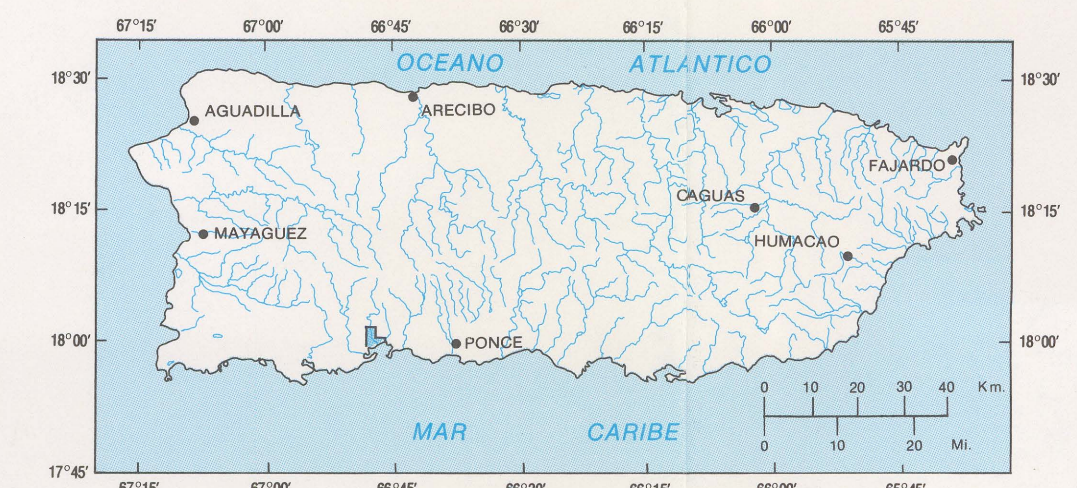
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FLOOD OF SEPTEMBER 16, 1975 IN THE GUAYANILLA VALLEY, PUERTO RICO

By
Karl G. Johnson

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
WATER RESOURCES INVESTIGATIONS
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INTRODUCTION

This report provides hydrologic and hydraulic information related to the flood of September 16, 1975, in the Guayanilla Valley. The information presented is a compilation of data recovered by the U.S. Geological Survey, and information provided by the residents in the study area.

The Guayanilla Valley (fig. 1) lies on the southwestern coastal plain of Puerto Rico about 15.3 km west of the city of Ponce. The town of Guayanilla is located in the upper part of the flood plain of the Rio Guayanilla. The climate on the coastal plain is semiarid with a mean annual precipitation of 1,140 mm, while in the mountainous area of the southern slopes of the Cordillera Central the mean annual is 2,000 mm. The average daily temperature ranges from 27°C in the winter to 29°C in the summer.

Most of the valley is dedicated to agriculture with sugarcane the main crop. Beginning in the early sixties some heavy and light industry moved into the lower part of the valley starting a trend toward changing the economy to industrial. This trend has created the need to utilize the flood plain to meet the continuous growth of the Guayanilla urban area.

This report provides valuable information for planners and designers in making decisions regarding development of the flood plain in the Guayanilla Valley.

Data are generally referred to in SI (International System) units. The SI units may be converted to inch-pound units by multiplying the units given by the factors shown.

Multiply SI units	By	To obtain inch-pound units
	Length	
meter (m)	3.2808	foot (ft)
millimeter (mm)	0.03937	inch (in)
kilometer (km)	0.6214	mile (mi)
	Area	
square kilometer (km ²)	0.3861	square mile (mi ²)
	Discharge	
cubic meter per second (m ³ /s)	35.31	cubic foot per second (ft ³ /s)
	Temperature	
degree Celsius (°C)	1.8 °C + 32	degree Fahrenheit (°F)

RIO GUAYANILLA BASIN

The Rio Guayanilla basin is located on the southwestern slopes of the Cordillera Central (figure 1). The Rio Guayanilla flows in a southerly direction from the rugged hills through steep slopes into a fan-shaped alluvial valley with milder slopes, and empties into Bahia de Guayanilla on the Caribbean Sea. The basin has a drainage area of 47.9 km² at the U.S. Geological Survey gaging station 50124000 (discontinued); and 53.9 km² at gaging station 50124500. The total drainage area of the basin is about 80 km.

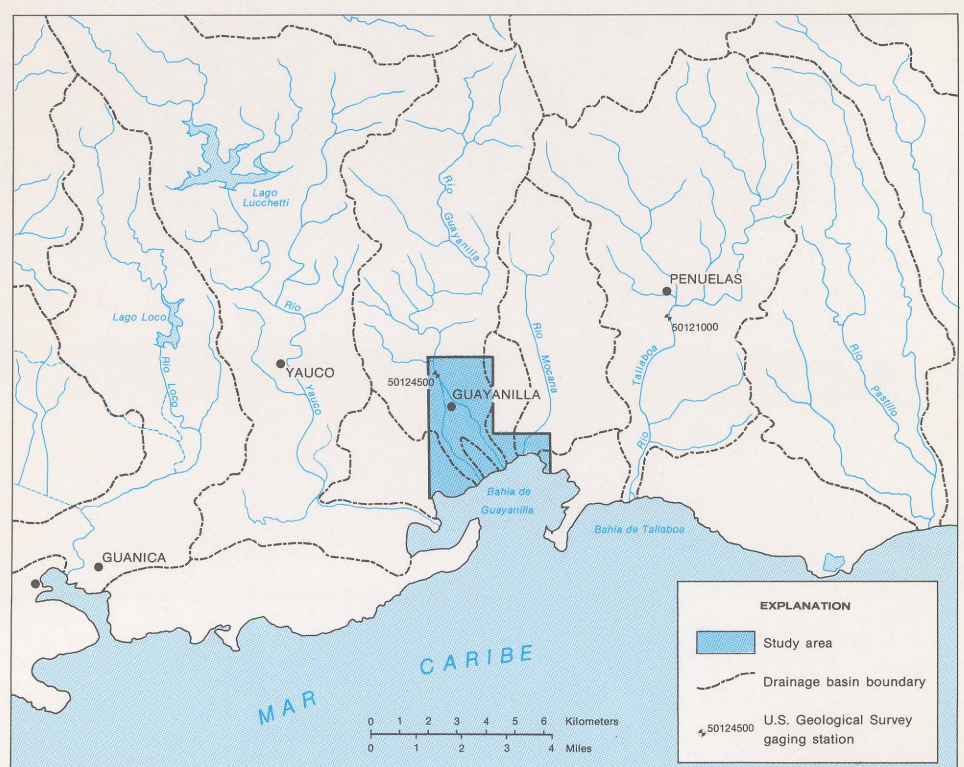
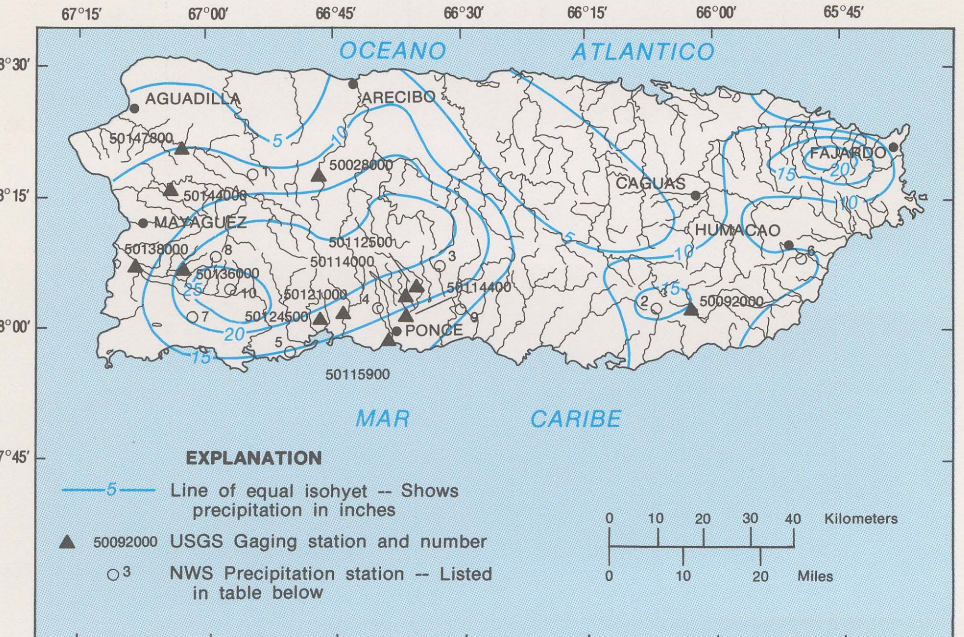


FIGURE 1. - Location of study area and the Rio Guayanilla drainage basin.

FLOOD OF SEPTEMBER 16, 1975

The passage of hurricane Eloise near the north coast of Puerto Rico caused torrential rains September 15, 16, and 17, 1975, producing destructive floods mainly in the southwestern part of Puerto Rico. Precipitation at 10 stations during September 15-17, 1975, and the distribution of precipitation throughout the island are shown in figure 2.



NUMBER ON MAP	LOCATION	PRECIPITATION, OF SEPTEMBER 15-17, 1975 IN INCHES				TOTAL
		SEPT 15	SEPT 16	SEPT 17		
1	ADJUNTAS SUBSTATION	0.15	11.99	4.87	17.01	
2	CARITE PLANT NO. 1	0.05	10.05	6.85	16.95	
3	CERRO MARAVILLA	0.46	16.00	2.37	18.83	
4	CORRAL VIEJO	0.10	7.58	8.26	15.94	
5	ENSENADA	0.05	5.41	10.30	15.76	
6	HUMACAO	0.40	8.02	5.22	13.64	
7	LAJAS SUBSTATION	0.29	3.10	12.26	15.65	
8	MARICAO 2 SSW	2.32	6.05	14.10	22.47	
9	PONCE 4E	0.00	2.90	7.78	10.68	
10	SABANA GRANDE 2 ENE	1.20	14.00	11.50	26.70	

FIGURE 2. - Map of Puerto Rico showing isohyets for September 15-17, 1975. Locations of selected precipitation and stream-gaging stations, and table showing the precipitation for the selected stations.

The flood of September 16, 1975 was the fourth highest of record since 1899.

The U.S. Geological Survey recovered high-water marks in the flood plain and made an indirect measurement at the new Highway 2 bridge shortly after the flood. The peak discharge was 630 m³/s.

Photographs of selected sites in the Guayanilla area during the September 16, 1975 flood are shown in figures 3-10 and figures 15-17. The photograph locations are identified on the flood map by a circular symbol with an identifying letter and an arrow showing the direction in which the respective photograph was taken. A rod marked in feet and a black arrow is used to point out the depth of floodwaters on some photographs.

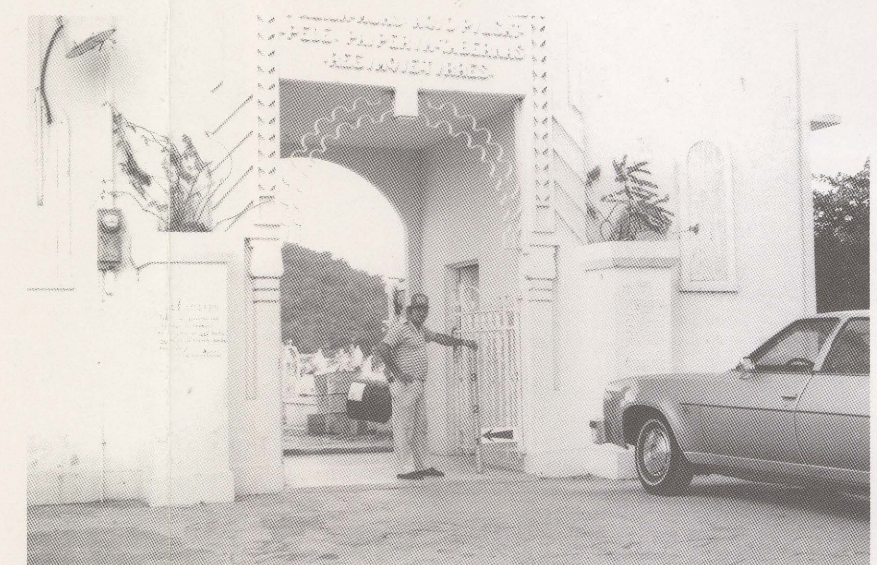


FIGURE 3. - Flood height (noted by arrow) at entrance of Guayanilla cemetery (photograph A).



FIGURE 4. - Flood height (noted by arrow) at pump house beside Guayanilla cemetery (photograph B).



FIGURE 5. - Flood height (noted by arrow) at Central Rufina on abandoned house (photograph C).



FIGURE 6. - Flood height (noted by arrow) in front of Central Rufina office building (photograph D).



FIGURE 7. - Flood height (noted by arrow) in front of Guayanilla Driving School (photograph E).



FIGURE 8. - Flood height (noted by arrow) at Casa Varma looking toward old Highway 2 bridge (photograph F).



FIGURE 9. - Flood height (noted by arrow) at harbor shop La Moderna looking toward old Highway 2 bridge (photograph G).

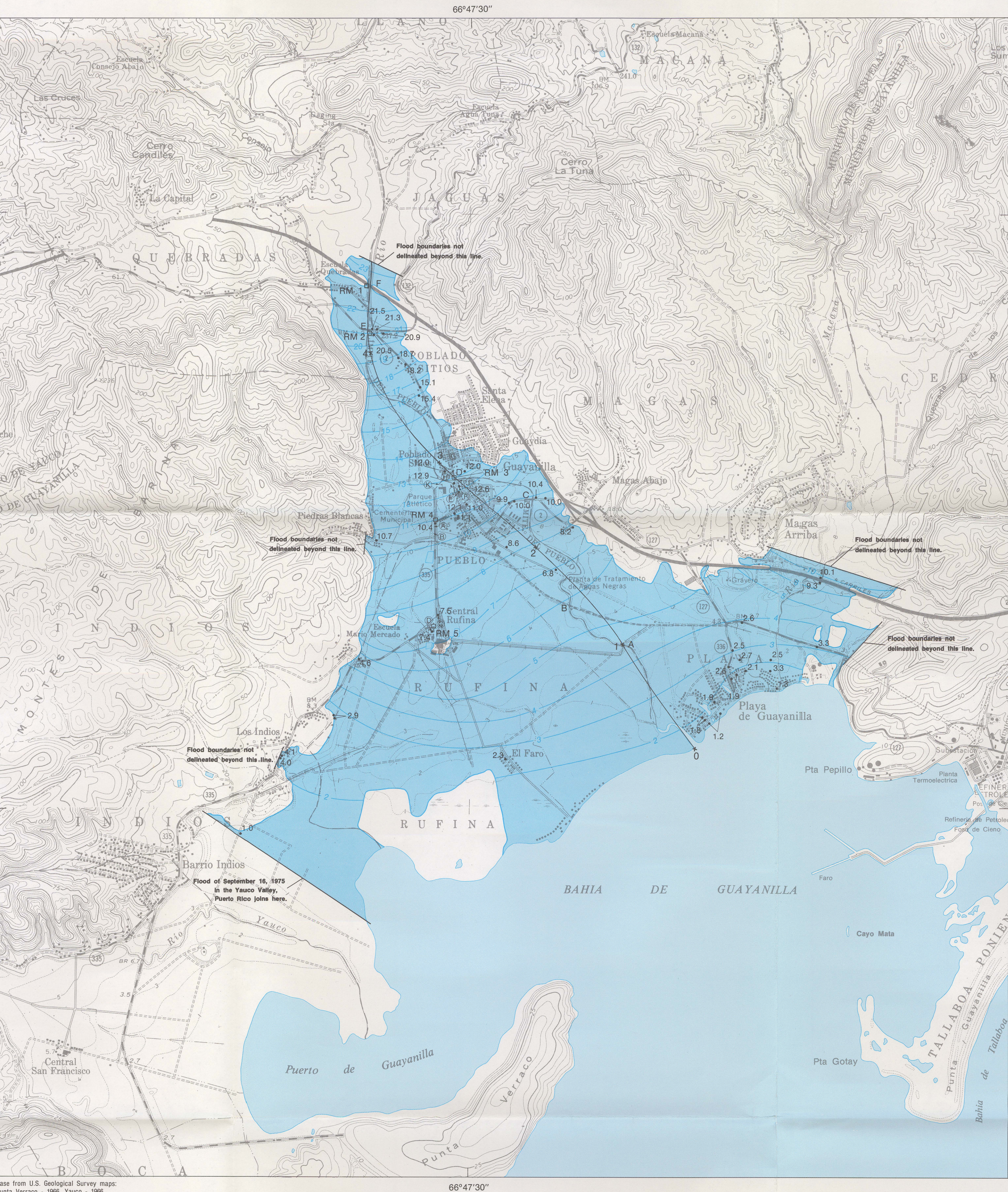


FIGURE 10. - Flood height (noted by arrow) in front of Texaco garage. A. Figueroa Torres, Inc. at sector Los Sitios, Guayanilla (photograph H).

FLOOD HISTORY

Historical records and interviews with residents in the study area indicated that the valley has experienced severe flooding at least nine times since 1899. The 1899 flood was the highest for which flood elevations could be delineated. Since 1899 major floods occurred in 1928, 1932, 1954, 1958, 1974, 1975, 1976 and 1979.

A stage-discharge relation was developed at station 50124500 (fig. 11). The relation was derived from peak-stage records at site 50124000, historical flood data, and current records at the site. The location of gaging stations 50124000 and 50124500, and the indirect-measurement site are shown in figure 12. The difference in drainage area between the indirect measurement site and the gaging stations is insignificant and no correction was applied to the measurement in this analysis.



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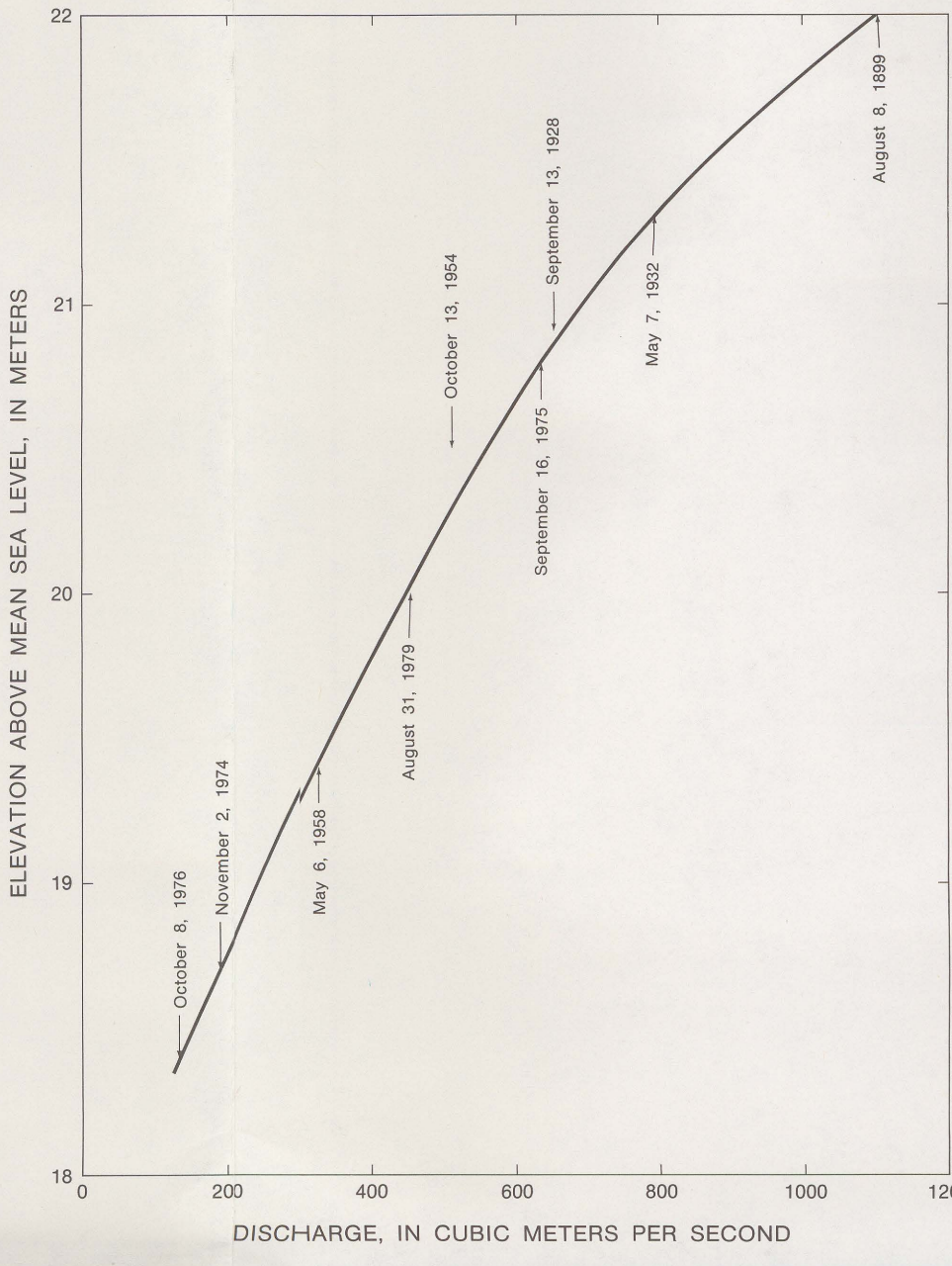
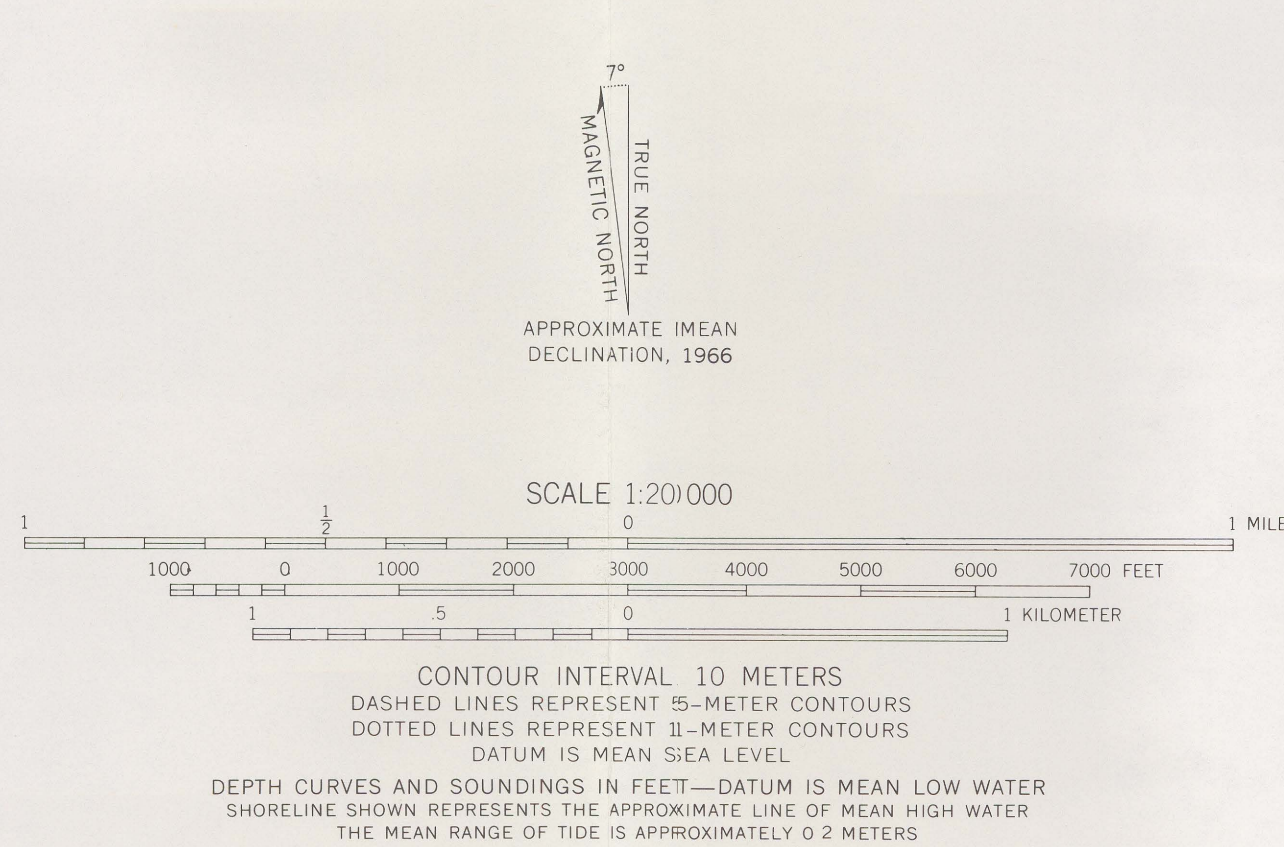
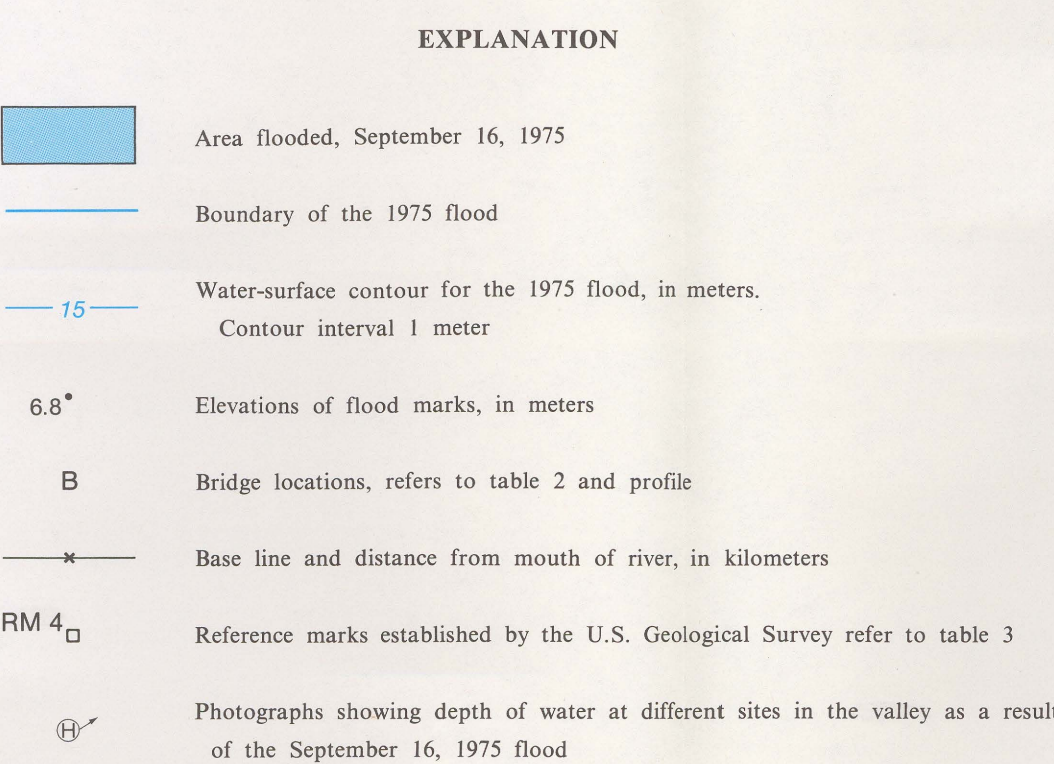


FIGURE 11. - Stage-discharge relation of gaging station 50124500 at Guayanilla, P.R.

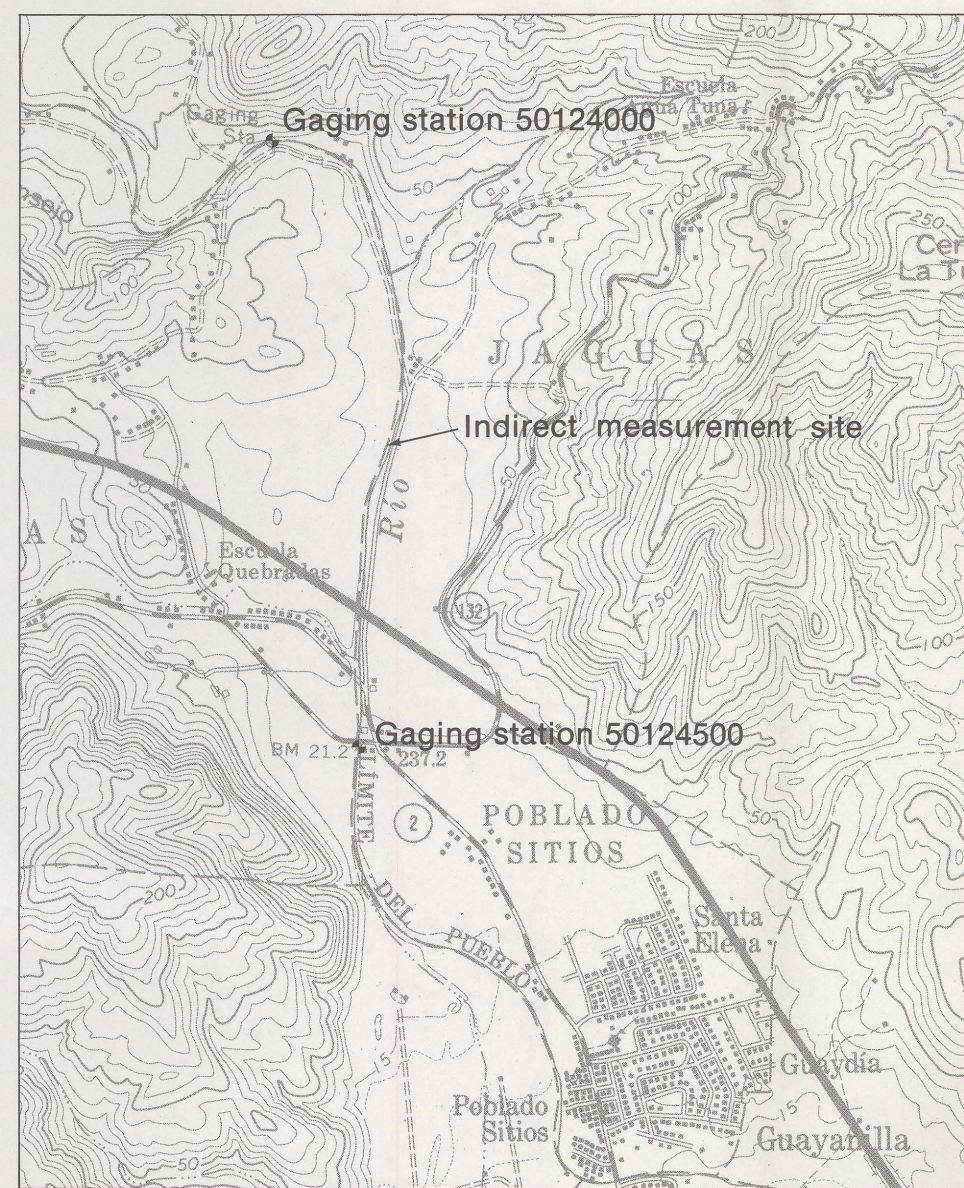


FIGURE 12. - Location of gaging stations 50124000 and 50124500 and indirect measurement site.

FLOOD FREQUENCY

Historical records were used to define a flow-magnitude frequency relation for Rio Guayanilla at gaging station 50124500. Peak-flow data for this relation were recovered from gaging stations 50124000 and 50124500 which were operated for a total span of 18 years.

Water Resources Council Bulletin 17A (appendix 8, 1977) recommends that the frequency relation at a gage site be determined by a weighting of the discharge for a selected frequency using the station data and data obtained by regional flood magnitude-frequency relation. This was done using the relation developed with the 18 years of station data and with results of a regional study accomplished by López and others, 1979. The resulting frequency curve is shown in figure 13. The recurrence intervals shown in table 1 were derived from this figure.

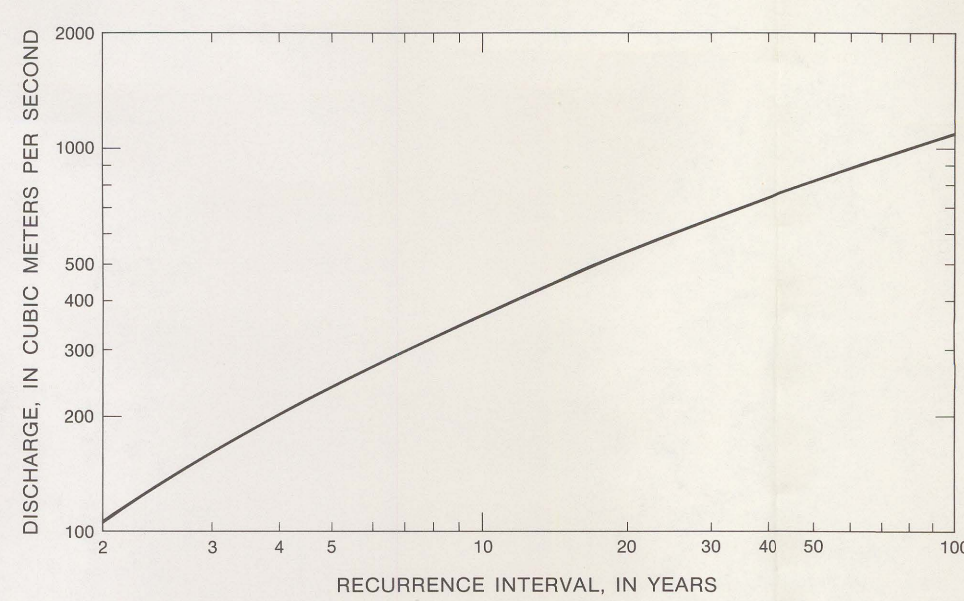


FIGURE 13. - Discharge frequency relation for station 50124500, Rio Guayanilla at Guayanilla, P.R.

Table 1.—Floods on the Rio Guayanilla at gaging station 50124500

Date	Elevation above mean sea level, meters	Peak discharge, cubic meters per second	Recurrence interval, years
August 8, 1899	22.0	1100	100
September 13, 1928	20.9	650	30
May 7, 1932	21.3	790	46
October 13, 1954	20.5	510	18
May 6, 1958	19.4	330	8
November 2, 1974	18.7	190	4
September 16, 1975	20.8	630	28
October 8, 1976	18.4	150	3
August 31, 1979	20.0	450	14

FLOOD PROFILES

The profile shown in figure 14 was developed from high-water marks recovered by the U.S. Geological Survey after the flood water receded and it represents the water-surface elevation above mean sea level for the September 16, 1975 flood. It is referenced to the arbitrary baseline shown on the flood map. The baseline, and therefore the profile, is not confined to the configuration of the channel but follows a smoother path along the flood plain in the general direction of the floodflow. There are seven bridges over Rio Guayanilla in the study area (table 2). Two of the bridges were destroyed by the flood.

Table 2.—Elevation of bridges over the Rio Guayanilla in the study area

Map symbol	Stationing along baseline, in kilometers	Location of bridge	Elevation in meters (MSL)	Top deck	Low beam
A	0.98	Old railroad bridge on road to Central Rufina	4.6	3.7	
B	1.50	Abandoned railroad bridge	6.2	5.6	
C	2.30	Old Highway 2 bridge	9.2	8.2	
D	2.85	Old Highway 2 bridge	12.8	12.1	
E	4.18	Old Highway 2 bridge	21.2	20.3	
F	4.52	New Highway 2 bridge	25.5	24.3	

*Destroyed by the September 16, 1975 flood. The bridge over the auxiliary channel located on the coastline about 450 m east of mouth of Rio Guayanilla was destroyed by the September 16, 1975 flood and is shown on the flood map.

All elevations shown in the study are referenced to mean sea level datum. Permanent reference marks were established at selected points throughout the study area (table 3) and are shown on the flood map.

Table 3.—Reference marks established by the U.S. Geological Survey in the Guayanilla study area.

Reference mark number (see map)	Elevation (MSL), meters	Description of location
RM-1	27.20	Chiseled square painted red, on top of downstream side of handrail about 2.3 km northwest of Guayanilla town square.
RM-2	21.20	Standard tablet embedded in concrete on left downstream abutment on old Highway 2 bridge over Rio Guayanilla. Second bridge in downstream order.
RM-3	11.66	Chiseled square painted red on twin manhole foundation on left upstream side of old Highway 2 bridge over the Rio Guayanilla. Third bridge in downstream order.
RM-4	9.96	Chiseled square painted orange on sidewalk by water-meter box on left side of entrance to Guayanilla cemetery.
RM-5	6.72	Chiseled square painted orange on concrete base of sugarcane weighing scale at entrance gate to Central Rufina.

WATER-SURFACE CONTOURS

Water-surface contours are based on the elevations of high-water marks recovered after the September 16, 1975 flood. These contours represent equal elevations of the water surface and are normal to the direction of flow. Some irregularities in the shape of the high-water contours occur due to obstructions to the flow, such as sugarcane, highway embankments, and housing areas in the valley. The approximate depth of flooding at any point in the inundated area can be estimated by subtracting the ground elevation contour from the water-surface elevation contour. Intermediate estimates of depth can be obtained by interpolation.

INUNDATED AREA

The area inundated by the September 16, 1975 flood has been delineated on a topographic map with a 10-m contour interval, scale 1:20,000. The flood boundaries were delineated using the high-water marks and field inspection of the flooded area immediately after the inundation. Where shallow depths occurred, the flood boundaries were not delineated on the topographic maps. The pattern of inundation of future floods, even of the same magnitude, will be affected by new highways and bridges, new buildings, landfills, or by relocation or excavation of the stream channel. The photographs in figures 15-17 show channel improvements upstream and downstream of old Highway 2 bridge after the September 16, 1975 flood, which will cause changes in the flood pattern of future inundations.

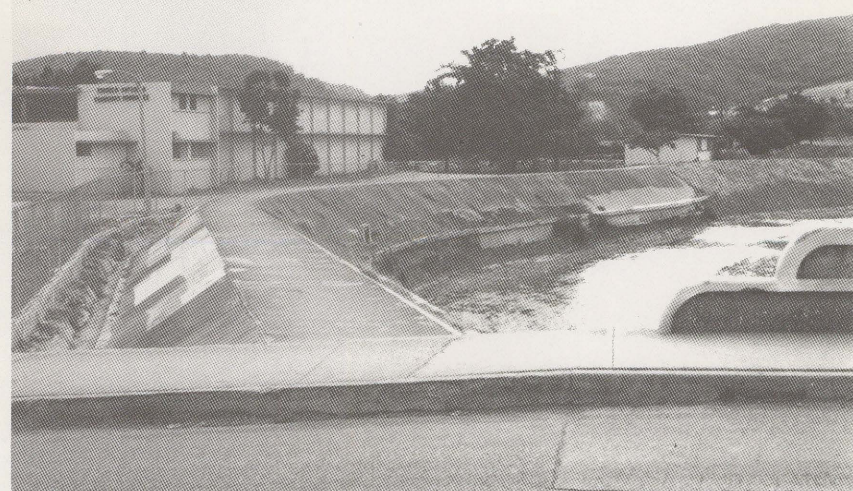


FIGURE 15. - From old Highway 2 bridge (D) looking upstream (photograph I).



FIGURE 16. - Looking from right bank toward left bank in the vicinity of old Highway 2 bridge (D) (photograph J).

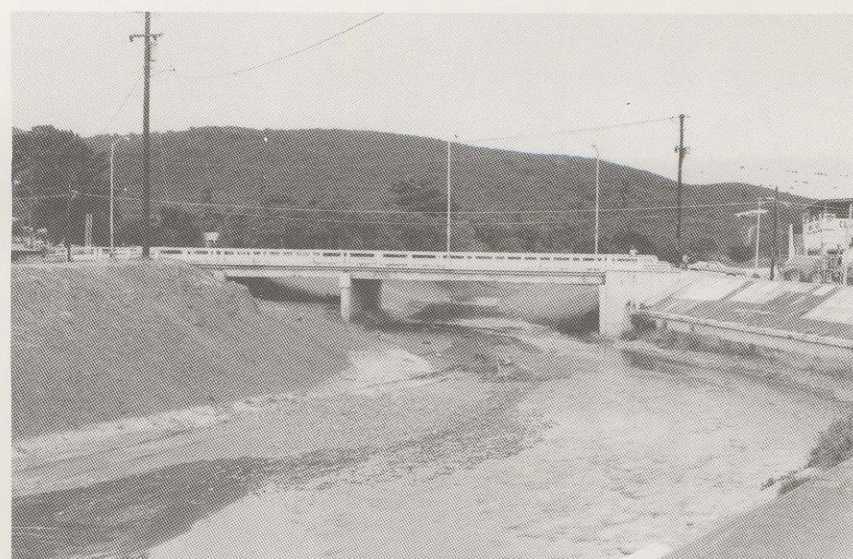


FIGURE 17. - In the vicinity of old Highway 2 bridge (D) looking downstream (photograph K).

COOPERATION AND ACKNOWLEDGMENTS

This report was prepared under a cooperative agreement between the Puerto Rico Department of Natural Resources, the U.S. Army Corps of Engineers, and the U.S. Geological Survey.

ADDITIONAL INFORMATION

Additional information related to this report can be obtained from the U.S. Geological Survey, San Juan District Office, G.P.O. Box 4424, San Juan, Puerto Rico 00936.

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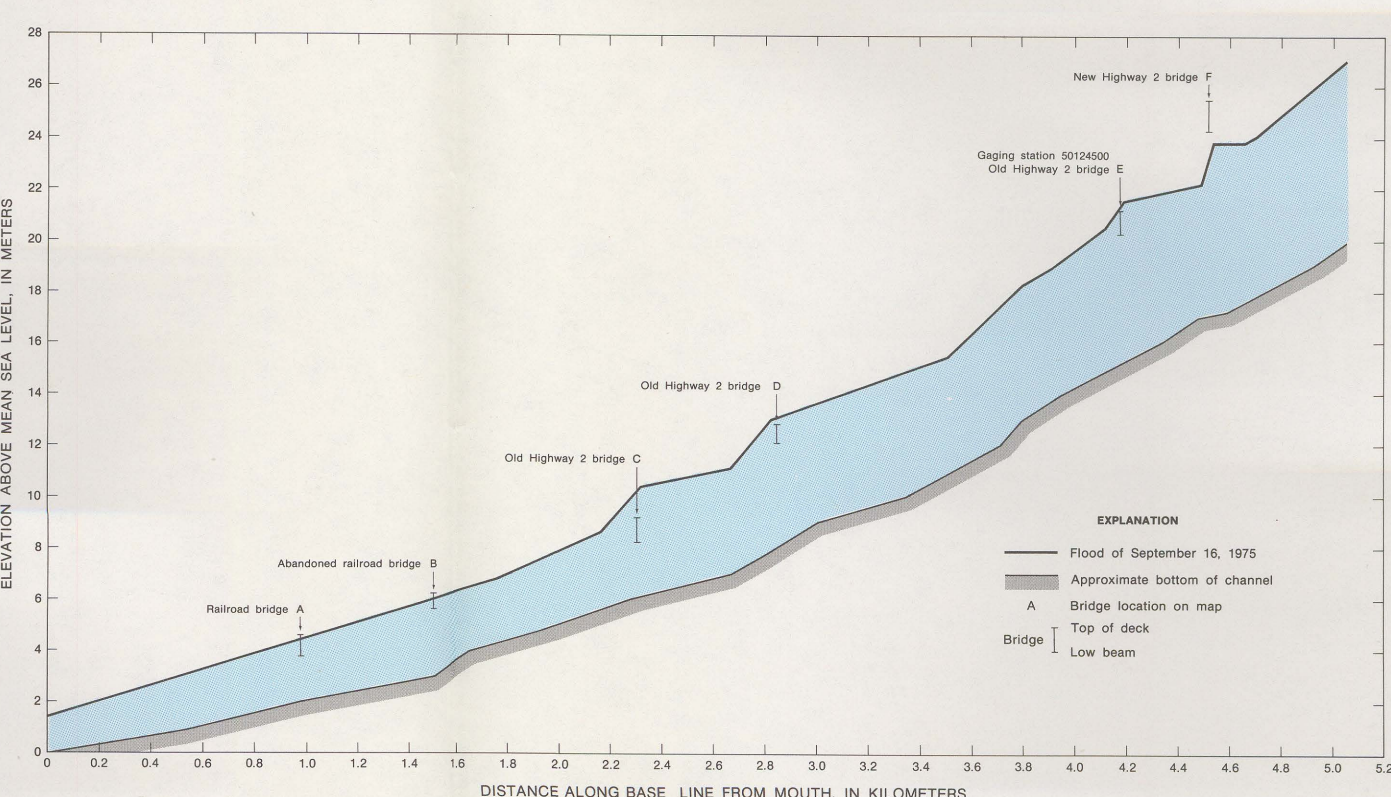


FIGURE 14. - Profile of Rio Guayanilla during the September 16, 1975 flood.